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(54) **Columns.**

(57) A column, as used to support overhead electrical power or telephone lines, comprises a series of members at least one (1) of which is compressively resilient while the others (2) are relatively rigid, and tensionable means (4, 5) which when tensioned secures the members (1, 2) in a fixed relationship constituting the column with the or each compressively resilient member in compression. Such column enables the dissimilar strength properties of the different members (1 and 2) to be fully utilised at the maximum flexural condition of the composite structure.

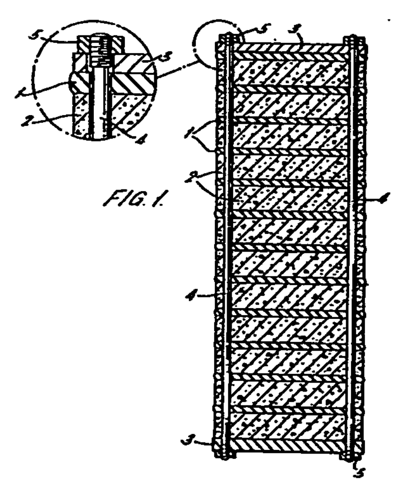

FIG. 1.

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Description

COLUMNS

This invention relates to columns, and in particular to columns as used to support overhead electrical power or telephone lines.

Overhead lines are generally supported by columns in the form of wooden poles even though such columns suffer from a number of disadvantages. Wooden poles are irregular in size and shape, and their properties are not accurately predictable. Further, wood is vulnerable to biological decay which is difficult to detect at an early stage and also difficult to arrest even when detected. Wooden poles are costly to repair and generally any repairs carried out do not return the pole to an as-new condition particularly with regard to appearance.

According to this invention there is provided a column characterised by a series of members at least one of which is compressively resilient while the others are relatively rigid, and tensionable means which when tensioned secures the members in a fixed relationship constituting the column with the or each compressively resilient member in compression.

Preferably the tensionable means and the or each resiliently compressible member are so prestressed by tensioning of the tensionable means, and the thickness of the or each resiliently compressible member in relation to its cross-sectional area and the positional distribution of the tensionable means is such that when the column is subjected to bending along its axis, the tensionable means and the or each resiliently compressible member experience their maximum allowable stress simultaneously.

Most composite materials such as fibre-reinforced plastics, steel-reinforced concrete or simply brick-mortar combinations, tend to rely for their limiting flexural strength on, among many other factors, the efficiency of the interfacial adhesion between the components. The interfacial bond is therefore the means by which a stress may be shared by the components. Since the strength properties of the components generally differ considerably, the weaker component often dictates the limiting stress, thus preventing the stronger component from being fully utilized.

Incompatibility between different production processing conditions for the components sometimes prevents direct composition, in useful form, of certain parts of components whose combination may otherwise be attractive and advantageous. For example, a combination of brick and steel falls into this category. Although it is conceivable that fully processed steel and brick may be combined by the introduction of a third component acting primarily as an adhesive, the limitations referred to in the foregoing paragraph will be further compounded. If it is required to utilize the favourable properties of compression for the brick and tension for the steel without an adhesive bond, then in all practical configurations of this material combination it appears that the overall flexural strength is limited solely by the brick strength. If the steel is not pre-stressed, then its tensile strength cannot be fully utilized, and if it is pre-stressed it can be shown that, unless the full range of permissable strain is represented in a scan of the total steel cross section at maximum flexure conditions, the steel is not providing its maximum potential strength contribution to the flexural resistence of the overall structure.

The basic reason for this stems from the large difference which may exist between the permissable strain values of the two components. During flexure, the strain range of one of the components (ie brick) is exhausted, whilst that of the other component (ie steel) is only partly developed.

The column of this invention constitutes a composite structure which enables the dissimilar strength properties of the different components to be fully utilized at the maximum flexural condition of the composite structure.

This invention will now be described by way of example with reference to the drawings, in which:-

Figure 1 is a vertical cross-sectional view of a column according to the invention;

Figure 2 is a plan view of the column of Figure 1;

Figure 3 is a diagrammatic representation of part of another column according to the invention;

Figure 4 is a plan view of part of a tensionable means securing plate used in a column according to the invention;

Figure 5 is a view on the line A-A in Figure ;

Figure 6 is a diagram illustrating connection of a tensionable means to an intermediate other member of a column according to the invention;

Figure 7 shows plan and side views of a member for use in a column according to the invention; and

Figure 8 illustrates a method of locating tensionable means in a column according to the invention.

Referring to Figures 1 and 2, the column here shown comprises a series of alternate compressively resilient members 1 of rubber or elastomeric plastics material and other relatively rigid members 2 of, for example concrete, fired clay brick, stone, graphite, ceramic material or cermet material. The series of members 1 and 2 is terminated at each end by a metal plate 3 of, for example, steel. Tensionable means in the form of metal rods 4 of, for example, steel, extend through holes in the members 1 and 2 and plates 3, and carry at their ends nuts 5 in screw-thread engagement therewith. After assembly the nuts 5 are tightened to obtain tensile stressing of the rods 5 and compressive stressing of the members 1 and 2, and particularly 1, as described above. As shown by Figure 2, the members 1 and 2, and plates 3, are circular in cross-section, and there are eight rods 4 equispaced about the periphery of the column.

The column described above is suitable for use

when it is expected to be placed under a uniform bending movement.

The tensile and compressive components 1 and 4 of the column are critically pre-stressed and the thicknesses of the members 1 are so proportioned in relation to their cross-sectional areas and in relation to the positional distribution of the rods 4 in tension, such that when the column is subjected to bending along its axis in a selected direction, the main tensile and compressive components 1 and 4 will encounter their maximum allowable strain range simultaneously as each encounters its maximum allowable stress.

Such a cylindrical column can be expected to withstand flexure equally whatever the selected direction of applied bending, and thus cannot be made as materially efficient as optimised equivalent columns whose major direction of flexure is predetermined.

An advantage of circular columns when used as overhead electrical power or communication line supports, is that they do not need to be erected at any particular orientation of the column about its axis. The bending moments to which such supports are normally subjected tend to be greatest at the ground line, and reduce linearly from there up to the position where the major bending force is applied. The regions of reduced bending moment can usefully be reduced in cross-sectional area to operate at the same stress levels as those met at the ground-line region.

Such a cross-sectional area reduction can be applied to both the tensionable members and the resiliently compressible members of a column according to this invention.

One column including this feature and specifically intended for an overhead line support is shown in Figure 3 (not to scale) which shows the core of a cylindrical column having a total height of 14m. This column consists of 131 modules arranged in six groups with the members in the lowest group having a diameter of 242 mm, and the diameters of the members in each successive group being reduced by 18 mm progressively.

Each module consists of a brick cylinder (member 2 in Figure 1) taking up about 97% of the module height, capped by a member of natural rubber (member 1 in Figure 1) filling the remaining 3% of the module height. The height of each module made up of a member 1 and a member 2 is approximately one half of its diameter.

The rubber members 1 may be separate mouldings secured to the associated brick members 2 by a suitable adhesive. As a method of improving the conformity of adjacent rubber and brick members 1 and 2 the column may be held horizontally in an alignment fixture whilst heat and axial pressure are applied in sufficient degree to allow localised surface re-moulding of the rubber members 1 to take place. To avoid localised over compression, small removable metal spacers can be placed at the periphery of each rubber member 1 either during an initial moulding thereof or in a separate operation during column assembly. By using suitable die boxes having flexible circumferential seals and temporary cavity spacers, it is possible to mould the rubber members 1 in situ between the brick members 2 against which they will bear in service.

Surrounding the compressive core shown in Figure 3 is a tensile shell comprising a plurality of 3.65 mm diameter high tensile steel wires 4 having their axes approximately vertical and circumferentially disposed around the core in a uniform manner. The position of expected maximum bending moment on the column (the ground line at 1.8m from the base) is spanned by 160 tension wires having their upper and lower ends anchored at different heights up the column such that the numbers surrounding regions progressively more remote from the ground line reduce in an ordered manner to provide approximately just sufficient tensile strength to withstand the reduced bending moments to which these regions may be subjected. The approximation in each case errs on the side of excess strength.

The full height of the column is spanned by 48 wires 4 anchored to steel plates 3 placed at the upper and lower ends of the column, and Figures 4 and 5 show the preferred method of anchoring the wires to the plates.

As shown, each wire 4 passes outwards through a hole 6 in the plate 3, the hole 6 extending from the periphery of the plate 3 at an angle to the axis of the column, to a position on the outer surface of the plate 3. The wire 3 is then turned to extend back along the column, the surface of the plate 3 over which the wire 4 passes being contoured to provide a smooth curve in the wire 4, as clearly shown in Figure 5.

At intermediate regions of the column the wires 4 are anchored directly to the brick members 2 of modules, and Figure 6 shows a method by which a pair of vertical strands formed from a single wire 4 may be anchored to a brick member 2 penetrated by a single diametral hole 7 each end of which is bell-mouthed to avoid causing sharp bends in the wire 4. This method ensures that both strands of the wire 4 will be subjected to similar instantaneous stress cycles, to avoid the likelihood of slippage which could occur during column flexure if the wire 4 simply passed through the brick member 2 to produce two diametrically disposed strands, one in greater tension than the other. The bell shaped mouths of the hole 7 can be lined with metal ferrules to prevent the wire 4 from transmitting excessive local stresses to the brick member 2. The periphery of the brick member 2 can be formed with a circumferential groove 8 to receive the wire 4.

The necessary number of wire-number reducing positions above the ground line is generally so small that less than half of the brick members 2 are required to serve as anchors, and of these none is required to anchor more than two strands as shown in Figure 6. Due to its shorter length, the part of the column below the ground-line includes a relatively large number of wire-anchoring brick members 2, with more than four fifths of such members providing anchorage for up to eight strands. Brick members providing such anchorage can be provided with two diametral holes (7 in Fig. 6) with two strands passing through each end of each hole.

Pairs of strands rising from anchorage brick members 2 below the ground-line are connected to opposing pairs of strands hanging from anchorage brick members above the ground-line by any convenient method. Where it is expected that subsequent re-adjustment of the tension in the wires 4 will be required adjustable connectors should be used. Where no re-adjustment of tension is likely to be required, the wires can be connected by crimped connectors. The wires 4 are placed in tension before the connectors are fitted, and preferably all wires 4 are tensioned simultaneously to a stress of approximately half of the maximum value allowed for in the worst flexure condition of the column.

Apart from the torsional resistance of the brick or rubber members 2 and 1 and any friction-limited torsional resistance of the interfaces between the members, additional torsional resistance is provided in that any attempt to twist the column will tend to increase the length of the already tensioned wires 4. Such torsional resistance can be substantially increased by initially introducing a relatively small helical path (typically 1° angle of helix) to the wires 4 in a balanced mode such as for example, making alternate pairs of strands follow a right hand and left hand spirals respectively.

Where additional torsional resistance is required or alternatively where the slight loss in bending resistance resulting from helical wires 4 cannot be tolerated, then it is possible to introduce some measure of keying at the inter module junctions. Figure 7 shows a brick member 2 the upper and lower mating faces of which are vee shaped, one side being convex and the other concave. The inclusive angle of vee would typically be no less than 168° inclusive and symmetrical about the column axis. In order to avoid all wire-anchoring cross holes being lined up vertically the vee channel direction of the concave face is angularly offset from the direction of the ridge of the convex face by a small angle, typically 3°. In assembly, the convex face is placed uppermost. The upper and lower anchor plates 3 can be shaped to mate with the respective convex and concave faces of the adjacent brick members 2, or the top and bottom brick members can have plain upper and lower faces, respectively.

It is preferable to bind the wires 4 at their peripheral locations to minimise adverse bending moment generation from the column components when large deflections are initiated by external forces. For example, when the column deflects, the wires originally adjacent to the neutral surface of the bending column, instead of following the bending arc of the neutral surface, would remain straight, forming a chord to the neutral surface arc, and, although reduced in length and stress, would be exerting a bending moment (cross bow style) on the bent column of the same sense as that causing the initial bend.

Figure 8 shows a wire location and binding arrangement which almost entirely eliminates such undesirable phenomena. Flat wire-locating rings 8 are placed around the smaller diameter brick member 2 at each column step, resting on and overhanging the upper face of the supporting brick member 2 of larger diameter. Each ring is penetrated by a plurality of equispaced oval slots 9 radiating from the centre. The slot width just accepts the wire 4 freely but its radial length allows considerable radial movement (typically 4 mm) of the wire 4. The number of slots 9 is arranged to correspond with the number of wires 4 which span the step. The radial position of the slots 9 is selected to allow clearance between the slot ends and the wires 4 when the latter are held in contact with the upper periphery of the supporting brick member 2.

Immediately below each locating ring 8 the wires 4 are bound to the supporting brick member 2 by any convenient means, for example by conventional metal strip binding material 10 or a re-usable worm wheel tightening clip.

Claims

1. A column characterised by a series of members at least one (1) of which is compressively resilient while the others (2) are relatively rigid, and tensionable means (4, 5) which when tensioned secures the members (1, 2) in a fixed relationship constituting the column with the or each compressively resilient member (1) in compression.

2. A column as claimed in Claim 1, characterised in that the or each compressively resilient member (1) is made of rubber.

3. A column as claimed in Claim 1, characterised in that the or each compressively resilient member (1) is of elastomeric plastics material.

4. A column as claimed in any preceding claim, characterised in that said other members (2) are made of concrete, fired clay brick, stone, graphite, glass, ceramic material or cermet material.

5. A column as claimed in any preceding claim, characterised in that the tensionable means comprises a plurality of metal wires (4).

6. A column as claimed in Claim 5, characterised in that the metal wires (4) pass through holes in the members (1, 2).

7. A column as claimed in Claim 5, characterised the metal wires (4) extend adjacent the periphery of and outside the members (1, 2).

8. A column as claimed in Claim 5, Claim 6 or Claim 7, characterised in that the metal wires (4) are secured to a mounting member (3) at each end of the column.

9. A column as claimed in any preceding claim, characterised in that the tensionable means (4) is secured to at least one of said other members (2) intermediate the ends of the column.

10. A column as claimed in Claim 9, characterised in that the tensionable means (4) is secured to the or each intermediate other member (2) by passing through a hole (7) therein and around the periphery thereof.

11. A column as claimed in Claim 10, characterised in that the periphery of the or each intermediate other member (2) is formed with a circumferential groove to receive the tensionable means (4).

12. A column as claimed in any preceding claim, characterised in that each other member (2) has one mating face formed in a concave V-shaped and the opposite mating face formed in a corresponding convex V-shape rotationally offset with respect to the V-shape of the one face (Figure 7).

13. A column as claimed in any preceding claim, characterised in that the members (1, 2) are sized to give the column a reducing cross-sectional area from one end to the other.

14. A column as claimed in Claim 13, characterised in that the cross-sectional area reduces in steps, these being a plurality of groups of members (1, 2) with the members in each group having the same cross-sectional area which is different from that of the or each adjacent group.

15. A column as claimed in any preceding claim, characterised in that compressively resilient members (1) and other members (2) alternate in the series.

16. A column as claimed in Claim 15, characterised in that each compressively resilient member (1) is secured to one other member (2) to form a unitary module.

17. A column as claimed in any preceding claim, characterised in that the or each compressively resilient member (1) contains rigid spacer members serving to limit compression of the member.

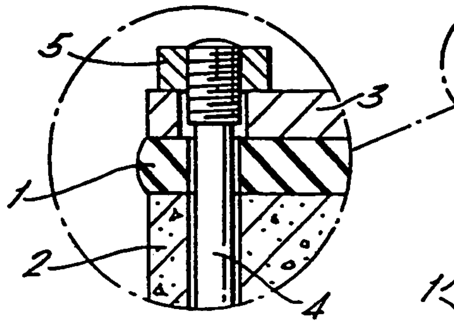
18. A column as claimed in Claim 14 as dependent upon Claim 7, characterised in that the tensionable means (4) are located at each step between adjacent groups of members by passing through slots (9) in a slotted plate (8) supported by a face of the larger cross-sectional area member (2) at the step.

19. A column as claimed in Claim 18, characterised in that the tensionable means (4) are bound (10) to the periphery of said larger cross-sectional area member (2).

20. A column as claimed in Claim 7, or any one of Claims 8 to 19 as dependent upon Claim 7, characterised in that the wires (4) extend in a helical path relative to the axis of the column.

21. A column as claimed in Claim 20, characterised in that the angle of said helical path is approximately 1°.

22. A column as claimed in any preceding claim, characterised in that the tensionable means (4) and the or each resiliently compressible member (1) are so prestressed by tensioning of the tensionable means (4), and the thickness of the or each resiliently compressible member (1) in relation to its cross-sectional area and the positional distribution of the tensionable means (4) is such, that when the column is subjected to bending along its axis, the tensionable means (4) and the or each resiliently compressible member (1) experience their maximum allowable stress simultaneously.



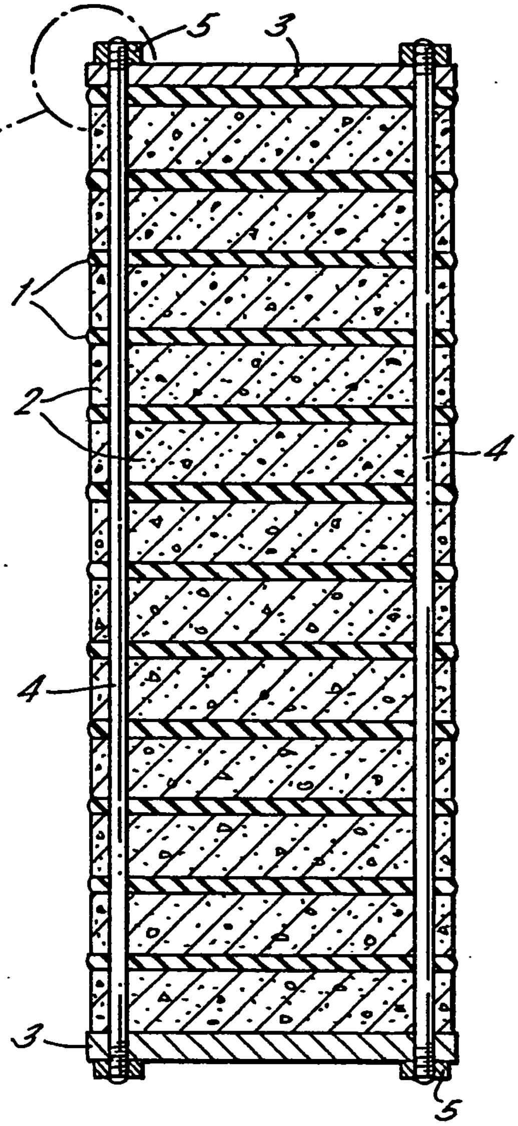
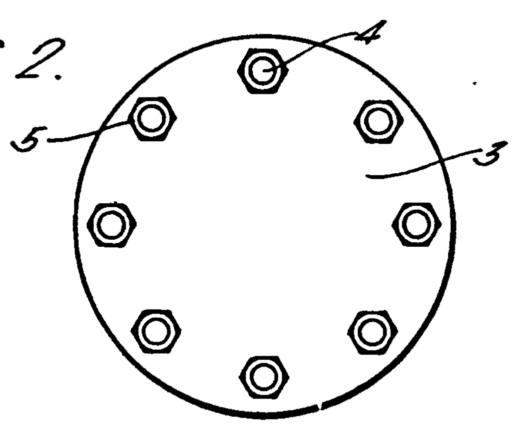


FIG. 1.

FIG. 2.



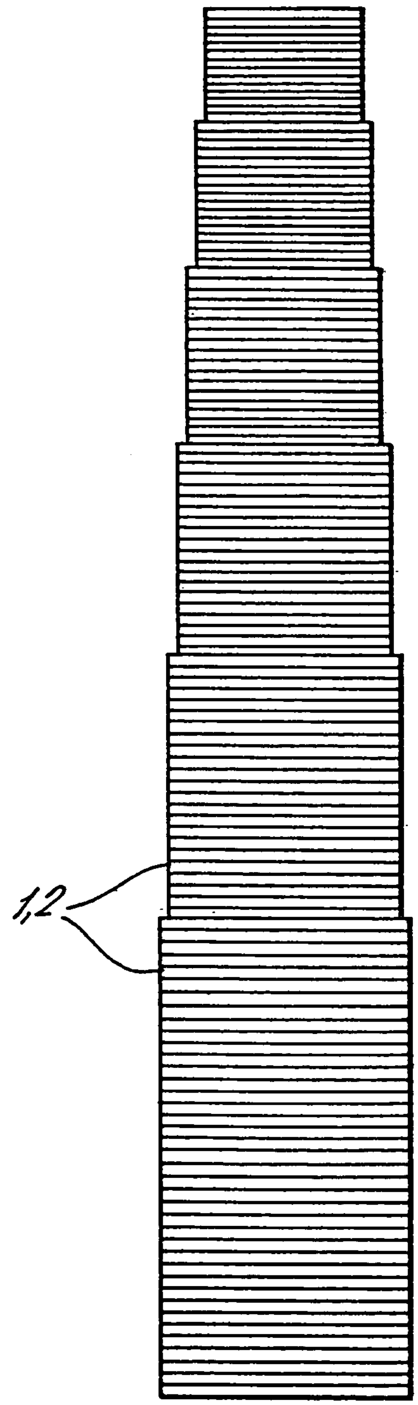


FIG. 3.

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FIG. 4.

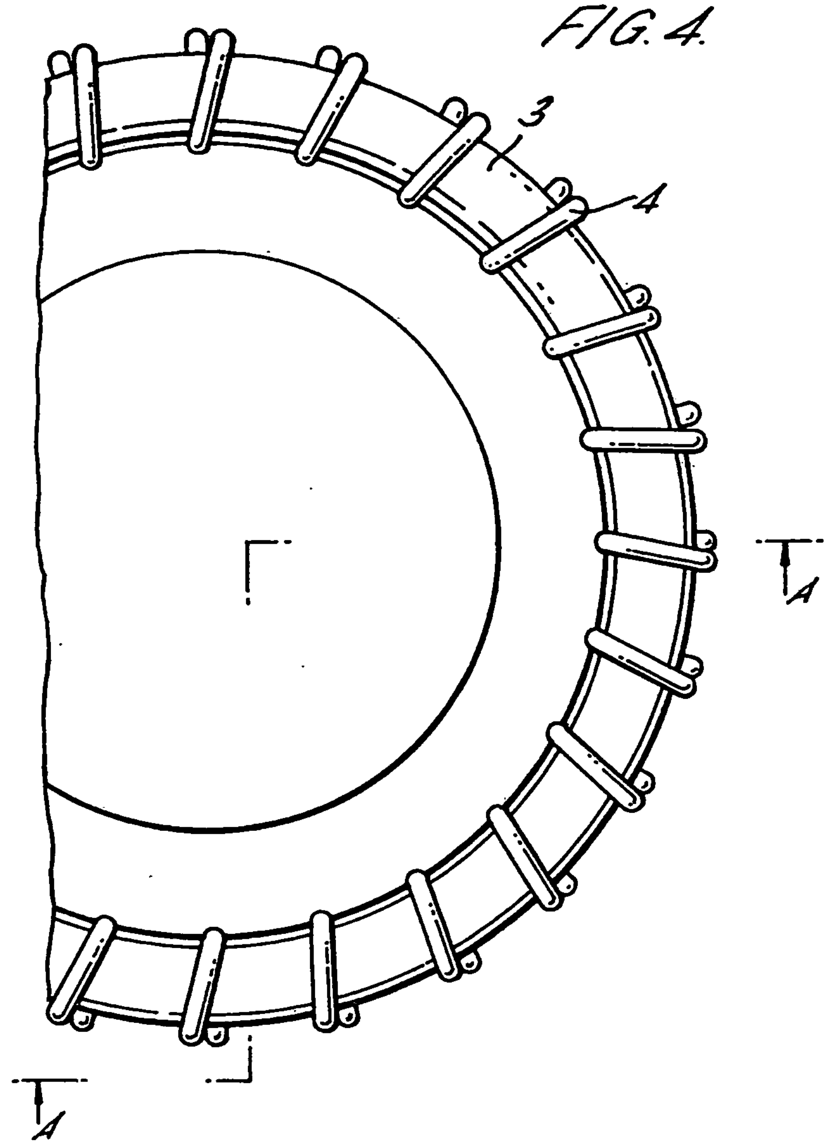


FIG. 5.

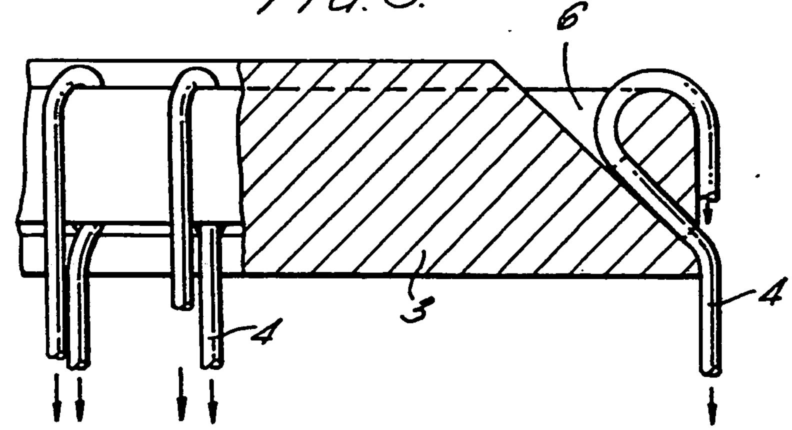


FIG. 6.

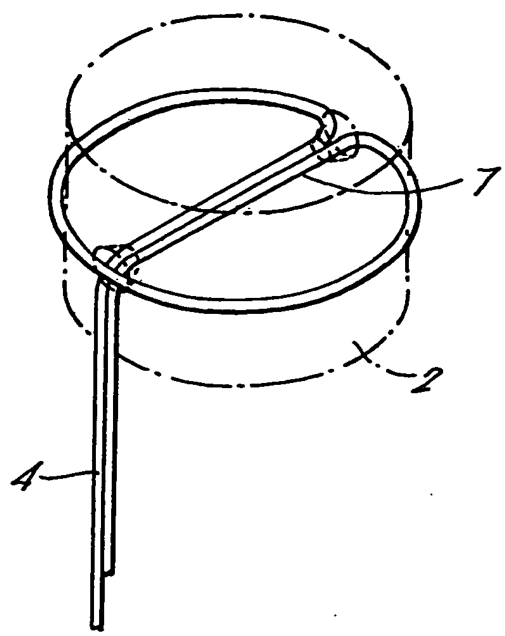
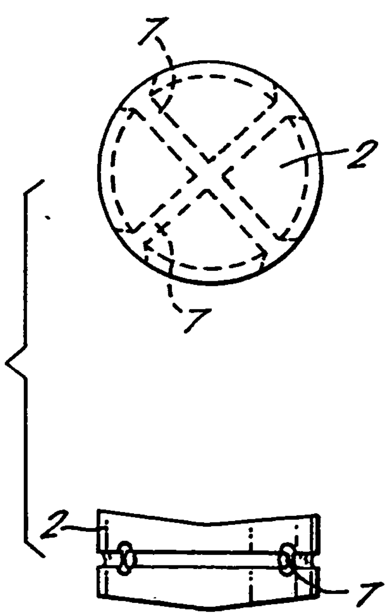


FIG. 7.



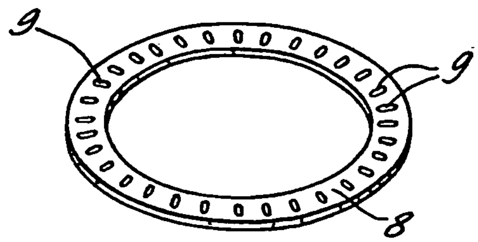
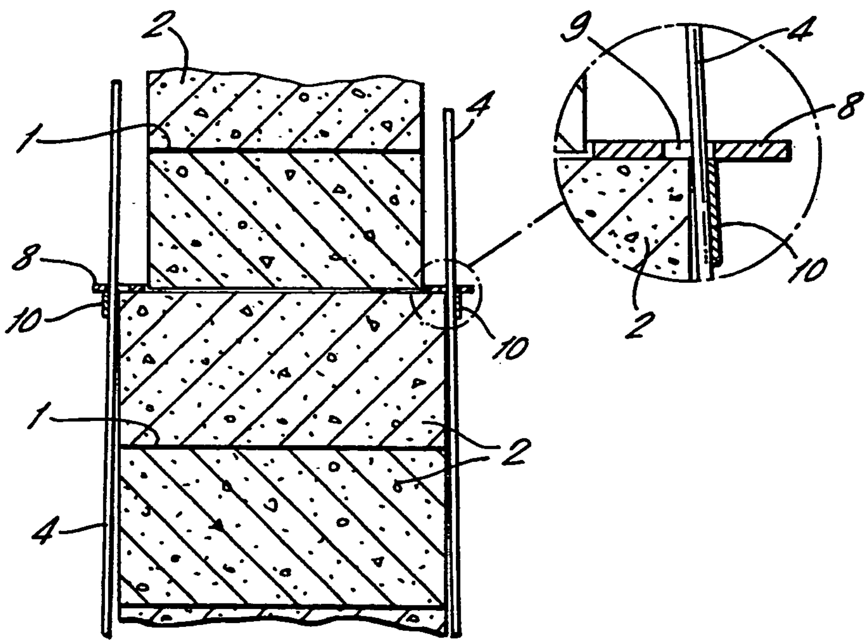


FIG. 8.



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EUROPEAN SEARCH REPORT

Application number

EP 87 30 3545

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	DE-A-2 229 581 (WILLIAMS) * Page 4, lines 28-29; page 5, lines 1-8; page 6, lines 29-31; page 7, lines 1-19; figures 1-6 *	1,2,6	E 04 H 12/16 E 01 F 9/01
A		5	
A	FR-A- 923 413 (GARNIER) * Page 1, lines 41-62; page 2, lines 1-37; figures 1,2 *	4,13, 14	
A	BE-A- 706 890 (LEISCHIK) * Page 3, lines 1-17; figure 1 *	7,8,18 -20	
A	FR-A- 377 961 (KASTLER)		
A	US-A-2 286 959 (HAINES)		

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

E 04 H
E 04 C
E 01 F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	03-08-1987	SCHOLS W.L.H.

CATEGORY OF CITED DOCUMENTS

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